Final Report
NRC Nuclear Education Grant Program
Georgia Tech Radiological Engineering Course Development
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Key Investigators:

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3. **Robert Rosson**, Senior Research Scientist, Environmental Radiation Center, EOSL, Georgia Tech Research Institute, Atlanta, GA 30332-0834, Robert.rosson@gtri.gatech.edu, 404-407-6339
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The activity funded under the award is development of a technologically intensive, well-rounded radiological engineering track within the nuclear engineering degree program. An existing course was revised. Originally three new courses were to be created; however, the loss of the third year funding allowed for only one course to be fully developed and taught. The other two course materials were partially developed but not completed but not finished and taught due to loss of funding. The radiological engineering track is scheduled to be voted on by the NRE faculty during the Fall semester 2011. It is anticipated that additional courses, such as a neutron detection course, will be added to the track in the future.

The Radiological Engineering track in the Nuclear and Radiological Engineering (NRE) M.S. Program to be voted on by the NRE faculty this coming fall is shown in Figure 1. The courses in Transport Fundamentals and Radiation Physics are currently required of all M.S. students in the NRE program. However, in comparison to the Nuclear Engineering Track, the required plasma physics and reactor physics courses are omitted as they do not contribute to the Radiological Engineering Track. The proposed track requires that the students take three existing courses: radiation protection, radiation detection, and a statistics course. A forerunner of the nuclear safeguards course has been taught as a special topics course for the last two years. The Radioanalytical Chemistry course has been developed and taught three times under this award. It has undergone revision twice during that time. Unfortunately, the number of enrollees has been rather limited and why more students were not interested in the course is not clear. The two course principally addressed with the funding are:

- The Radioanalytical Chemistry lecture course is based on a recently published textbook.[1] The course was designed to relate measured concentrations of radionuclides in the environment, in process streams, and bioassay samples to radiation exposure limits, and to plan programs for enforcing such limits. Regulations and implementation of the new Multiple Agency Radiological Laboratory Accreditation Program (MARLAP) was covered as well. Students learned to work in and supervise a radiochemistry laboratory, to submit appropriate samples for analysis, and to receive, evaluate, use and report radionuclide data from the laboratory. In addition to reviewing radiation detection and analytical chemistry principles, the course included application of these principles in the radioanalytical chemistry laboratory and counting room, laboratory design and management, quality assurance, and laboratory safety. The course is designed to be a 1-semester course with 3 one-hour lectures per week.
- The Radiological Assessment course addresses critical analyses of sources and human exposures; mathematical models through the biosphere; environmental transport, and exposure for nuclear facilities and waste disposal/processing. The development of source terms and exposure scenarios for radiological health risk assessments to evaluate the health impact of nuclear facilities will be undertaken. The existing course was modified to include dose assessment projects using industry standard environmental transport codes.

The effort originally proposed was to take three years to fully implement. As previously mentioned, since the program was only funded for 2 years, the entire proposed course development activities could not be carried out. In the Summer 2009 semester, the Radioanalytical Chemistry course was taught by Dr. Paul Charp, who is a scientist in the Agency for Toxic Substance and Drug Registry, Centers for Disease Control and Prevention (CDC). Although the enrollment was small since the course was delivered during the summer, its delivery offered an opportunity to refine the new course via built-in assessment tools described in previous progress reports.

During the Spring 2010 semester, the Radioanalytical Chemistry course was taught again, this time by Dr. Michael Nichols. Dr. Nichols, before his retirement from Georgia Power, managed the Georgia Power Environmental Laboratory's radiochemistry facility. He brought an immense amount of experience to the teaching of the course. He continued to upgrade the course as well as the powerpoint presentations. Dr. Nichols' CV is attached as is a brief list of the changes he made to the course and the course syllabus as he taught it. The updated powerpoint presentations are available at the following web site:

https://t-square.gatech.edu/access/content/user/DA3A615EEDAA6F28B2442E364350CA45/Radioanalytical Chemistry Course Spring 2010/

Dr. Nichols taught the course a second time during the Spring semester of 2011. His revised course outline is shown in Appendix A. He has agreed to teach it in the Spring Semester of 2011. We were granted a no cost extension so that we can cover his costs in teaching the course. So no real activity occurred during the last 6 month period. Hopefully, Georgia Tech will agree to fund an instructor to teach the course on an 18

[1] Bernd Kahn (ed.), Radioanalytical Chemistry, Springer, New York, 2007.

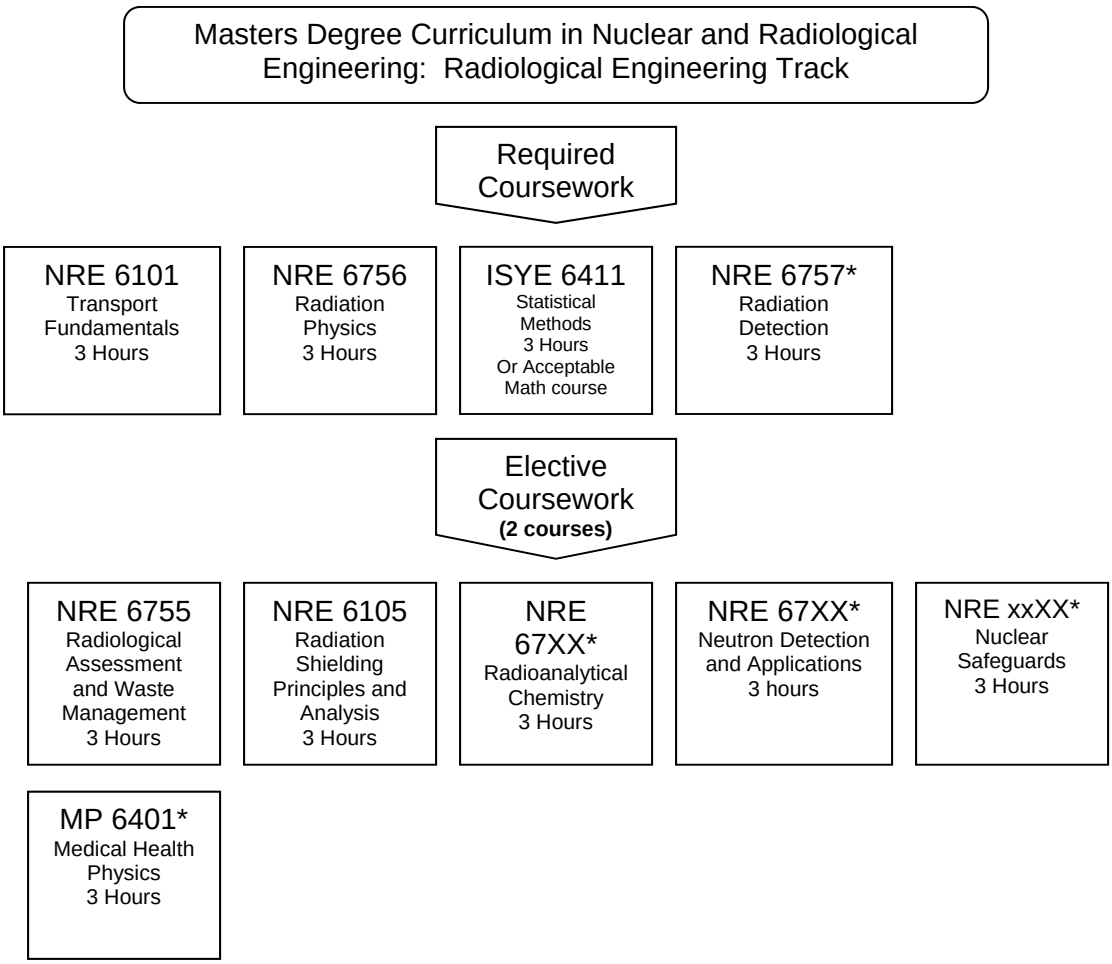

Figure 1. Radiological Engineering (Health Physics) Track Proposed in the MS NRE Program.

month cycle in the future. However, the low enrollment for first 3 courses may make that impossible.

Appendix A
Spring 2010 Edition of Radioanalytical Chemistry

NRE8803 Radioanalytical Chemistry was taught in Spring semester 2010. Three students enrolled, two in the undergraduate Nuclear and Radiological Engineering program and one in the undergraduate Chemical Engineering program. The course was again based on the text "*Radioanalytical Chemistry",* Bernd Kahn, Editor. The previously developed presentation material has been expanded by including current examples obtained from radiochemistry laboratories and illustrating important analytical concepts. Additional reference materials have been introduced to address the current state of regulatory guidance (see references below).

Specific additions include the following:

- Assignment of Currie (1968) Analytical Chemistry paper defining decision and detection limits;
- MARLAP Chapter 3 Analytical Planning issues;
- Overview of USNRC Regulatory Guide 4.15 Rev 2, ISO-17025, and MARLAP description of QA / QC programs;
- Problem sets illustrating concepts and testing understanding of materials covered;
- Gamma spectroscopy with Genie 2000 – mixed gamma energy and efficiency calibrations, peak search algorithms and parameters, library directed searches and deconvolution, ANSI N42.14 performance tests, identification of unknown gamma lines (^{232}Th decay series); and
- MARLAP and General uncertainty model guidance for developing uncertainty estimates.

<u>Additional References Used in the Spring 2010 Version of the Course</u>

1. L A Currie, Limits for Qualitative Detection and Quantitative Determination: Application to Radiochemistry, Analytical Chemistry 40(3):586-593; 1968.

2. NUREG-1576 Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) Volumes 1, 2, and 3

3. US NRC Regulatory Guide 4.15 Rev. 2 Quality Assurance for Radiological Monitoring Programs (July 2007)

4. US NRC Regulatory Guide 1.21 Rev. 2 Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste (June 2009)

5. US NRC Regulatory Guide 4.1 Rev. 2 Radiological Environmental Monitoring for Nuclear Power Plants (June 2009).

Outline for the Spring 2010 Version

This outline references presentations (*.pptx), references, and activities used Spring 2010 in NRE 8803.

1. Introduction to radioanalytical chemistry
    a. Radioanalytical Chemistry Chpt 1 Intro.pptx
    b. Reading
        i. Marie Curie 1911 Nobel lecture
        ii. NUREG 1576 Supplement 1 Overview of MARLAP
        iii. USNRC Regulatory Guides 1.21 and 4.1

2. Review of nuclear physics, radioactive decay, and radiation interactions with matter
    a. RC_Chpt2_1to4.pptx
    b. RC_Decay Equations.pptx
    c. Reference
        i. www.nndc.bnl.gov Chart of the Nuclides
        ii. Knoll, GF Radiation Detection and Measurement – Chapters 1 and 2

3. Review of radiation detection and measurement
    a. RC_Radiation Detection Chpt2_5.pptx
    b. Tour of radiochemistry laboratory

4. Principles of basic analytical chemistry
    a. RC_Chpt3Analytical Chemistry.pptx

5. Principles and practices of analytical chemistry and radiochemistry measurements
    a. RC_Chpt5and6.pptx

6. Application of radioanalytical chemistry – methods
    a. ASTM C 1507 Standard Test Method for Radiochemical Determination of Strontium-90 in Soil
    b. Eichrom Technologies, Inc. SRW01 Strontium 89,90 in Water
    c. ANSI N42.14 Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides

7. Laboratory sample preparation for measurement
    a. Review structure of laboratory procedure for strontium analyses
    b. Review implementation of gross beta, gross alpha, tritium, and alpha spectroscopy at Georgia Environmental Radiation Laboratory

8. Laboratory performance specification, verification, and validation – MARLAP
    a. RC_MARLAP.pptx
    b. Reading – MARLAP Chapter 3 Key Analytical Planning Issues

9. Measurements of radioactivity – performance characteristics and controls.
    a. Detection limits – Currie (1968) Limits for Qualitative Detection and Quantitative Determination Analytical Chemistry 40(3):586-590.

b. Exercises determining counting plateau of gas flow proportional counter, tritium counting window for liquid scintillation counting
c. RC_Chapt10Gamma Spectroscopy.pptx
d. Calibration and operation of Gamma Spectrometry system (Genie 2000)

10. Statistical process controls applied to radiochemistry measurements
    a. Instrument controls
        i. Background
        ii. Energy calibration, Counting Plateaus, Energy Windows
        iii. Efficiency
    b. Process Controls
        i. Blanks, Spikes, Duplicates
        ii. Yield
    c. Performance Testing
        i. Accuracy
        ii. Precision

11. Quality Assurance requirements – IAEA RS-G-1.8, ISO 17025, and USNRC Regulatory Guide 4.15
    a. RC_Chapter11 QAQC.pptx
    b. RC_MARLAP Decisions and Actions.pptx

12. Safety in the Laboratory – hazard identification, assessment, and control

NRE 8803 Radioanalytical Chemistry
Spring, 2011 Course Detail

This course provides a basic background in Radioanalytical Chemistry. The course provides a structure for understanding and using guidance, standards, and accessing radiochemical methods for a range of applications. The attached outline references the presentations, documents, and references that are applicable. The presentations have been reviewed and organized to provide a coherent structure for understanding the fundamental concepts of analytical radiochemistry.

The fundamental concepts addressed include:

- Principals of nuclear physics applicable to radionuclide decay and measurement of radiation;
- Radiation detection and measurement processes;
- Sources of interferences in radiation measurement resulting from the physics of ionizing radiation interactions and characteristics of radionuclides;
- Analytical chemistry applicable to isolating radionuclides and controlling interferences;
- Structure of analytical methods and procedures;
- Guidance and specification for measurements including USNRC Regulatory Guides and MARLAP (Multi-Agency Radiological Laboratories Analytical Protocols);
- Basic configuration and operation of common counting systems (gas flow proportional, liquid scintillation, alpha spectrometry, and gamma spectrometry);
- Hypothesis testing applied to Decision Limits, Detection Limits, and Action Levels; and
- Quality Assurance and Quality Control including process controls and performance evaluation.

Students in this course are introduced to fundamental literature including Currie's (1968) paper on detection limits, industry standards, current examples of applications of radiochemistry measurements, and guidance documents including MARLAP.

Course presentation material was reviewed and updated. Additional material was incorporated from a workshop developed for the US Food and Drug Administration addressing process control and uncertainty of measurements, supplementing Chapter 10 and 11 of the text. Examples of measurements and issues from releases at Fukushima Daiichi and monitoring in the US were provided and discussed.

Radioanalytical Chemistry

This outline references presentations (*.pptx), references, and activities used Spring 2011 in NRE 8803.

1. Introduction to radioanalytical chemistry (Chapter 1)
    a. Radionalytical Chemistry Chpt 1 Intro.pptx
    b. Reading
        i. Marie Curie 1911 Nobel lecture

2. Review of nuclear physics, radioactive decay, and radiation interactions with matter (Chapter 2)
    a. RC_Chapt2_1to4.pptx
    b. RC_Decay Equations.pptx
    c. Reference
        i. www.nndc.bnl.gov Chart of the Nuclides
        ii. Knoll, GF Radiation Detection and Measurement – Chapters 1 and 2

3. Review of radiation detection and measurement (Chapter 2)
    a. RC_Radiation Detection Chapt2_5.pptx
    b. Tour of radiochemistry laboratory

4. Principles of basic analytical chemistry (Chapter 3)
    a. RC_Chapt3Analytical Chemistry.pptx

5. Laboratory sample preparation for measurement (Chapter 4)
    a. Review implementation of gross beta, gross alpha, tritium, and alpha spectroscopy at Georgia Environmental Radiation Laboratory

6. Sample collection and application of specific methods (Chapters 5 and 6)
    a. RC_Chpt5and6.pptx
    b. Review plant specific Off-site Dose Calculation Manual and NUREG 1301/1302

7. Application of radioanalytical chemistry methods (Chapter 8 and 9)
    a. Calibration of Gas Flow Proportional Counter.pptx
    b. Liquid Scintillation Calibration.pptx
    c. Gamma Spectrometry Calibration.pptx
    d. Gamma Spectrometry.pptx

8. Laboratory performance specification, verification, and validation – MARLAP
    a. Regulatory Guides.pptx
    b. NRC Regulatory Guide 4.15 Rev 2 Quality Assurance Requirements,
    c. NRC Regulatory Guide 4.1 Rev 2 Radiological Environmental Monitorign

d. NRC Regulatory Guide 1.21 Rev 2 Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents

9. Measurements of radioactivity – performance characteristics and controls.
    a. Detection limits – Currie (1968) Limits for Qualitative Detection and Quantitative Determination Analytical Chemistry 40(3):586-590.
    b. Performance Testing.pptx

10. Statistical process controls applied to radiochemistry measurements (Chapter 10 and 11)
    a. What is uncertainty.pptx
    b. Decision Rules.pptx
    c. General Uncertainty Model.pptx

11. Quality Assurance requirements –ISO 17025, and USNRC Regulatory Guide 4.15
    a. NUREG 1301 and 1302
    b. MARLAP Analytical Protocol Specification

References:

Radioanalytical Chemistry; Bernd Kahn, Editor, 2007

Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), NUREG-1576 Volumes 1, 2, 3, and Supplement 1

Currie, LA Limits for Qualitative Detection and Quantitative Determination Analytical Chemistry 40(3):586-590 (1968)

US NRC Regulatory Guidance
US NRC Regulatory Guide 4.15 Rev 2 Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment

US NRC Regulatory Guide 4.1 Rev 2 Radiological Environmental Monitoring for Nuclear Power Plants

US NRC Regulatory Guide 1.21 Rev 2 Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents

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Decatur, Georgia
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Email: mcnichols@vzw.blackberry.net

Project Management – Health Physics and Environmental Assessments

Distinguishing Qualifications

- Experienced manager of multi-disciplinary project teams.
- Broad background in health physics and environmental sciences.
- Strong negotiating skills including experience with federal and state agencies.
- Experience with MARLAP general uncertainty model evaluations.

Professional History

Environmental Manager, Georgia Power Company, March 1992 to November, 2008

- Managed four analytical laboratory sections providing Radiochemistry, Dosimetry, Fuel, and Chemistry analytical services supporting nuclear, fossil, and hydro generation as well as transmission, distribution, and corporate organizations.
- Managed Environmental Field Services section supporting nuclear and hydro license renewal, transmission routing, facility site selection, radiological environmental monitoring, aquatic plant management, and water quality monitoring.
- Coordinated support of NEPA assessments for hydroelectric license applications, and nuclear plant license renewal.
- Responsible for 30 employees and operating budget of $3.8 million per year.
- Analytical programs meet the requirements of ISO 17025 :"General Requirements for the Competence of Calibration and Testing Laboratories" and accreditation is maintained with the National Voluntary Laboratory Accreditation Program (Dosimetry) and the National Environmental Laboratory Accreditation Conference (Chemistry).

Licensing Supervisor, Air and Water, Georgia Power, Feb 1991 to Feb 1992.
Health Physics and Chemistry Operations Supervisor, Georgia Power, June 1985 to Feb.1991.
Environmental Section Supervisor, Georgia Power, August 1983 to June 1985.
Staff Biologist, Georgia Power, 1978 to 1983.
Assistant Project Director, Institute of Ecology, University of Georgia, 1977 to 1978.

Professional Certification

Comprehensive Certification, American Board of Health Physics, 2006

Education

Ph.D., Radiological Engineering, Georgia Institute of Technology, 2009
M.S. Health Physics, Georgia Institute of Technology, 1985
M.S. Zoology, University of Georgia, 1978
A.B. Biology, University of Michigan, 1973

Professional Experience

Health Physics and radioactive materials

Design and implementation of radiochemical analyses for nuclear facilities

Established a Radiochemistry program for analyses of environmental and effluent samples to specifications of U.S.N.R.C. Regulatory Guide 4.15 "Quality Assurance Programs for Radiological Monitoring Programs ...".

- Provided centralized analytical services for three nuclear power sites.
- Established long term program with strong quality control, quality assurance, and performance testing results.
- Instrumentation includes gamma spectroscopy, liquid scintillation counting, low-background gas flow proportional counting, and beta-gamma coincidence counting.
- Developed sample preparation, analysis, and quality assurance procedures.
- Continued addition and expansion of centralized analytical services, expanded to include effluent samples (Sr-89/Sr-90, Fe-55, gross alpha).
- Supported analytical chemistry measurements for plant processes samples containing limited radioactivity.
- Experience with MARLAP general uncertainty model evaluations.

Managed development of personnel dosimetry program

Supervised the establishment of a personnel dosimetry program meeting requirements of ANSI N13.11. "Criteria for Testing Personnel Dosimetry Performance" and accredited under the National Voluntary Laboratory Accreditation Program.

- Provides centralized personnel dosimetry for three nuclear sites, providing dose of record for site personnel.
- Successfully completed NVLAP accreditation on first attempt.
- Exemplary NVLAP assessment and performance testing record since 1985.

Consultation with nuclear power facilities

Participated in formal and informal consultation with nuclear power facilities.

- Participated in an internal assessment of a nuclear facility quality control program as a member of a peer assessment team. Recognized by Health Physics and Chemistry Superintendent for expertise in identifying and resolving a significant statistical control issue.
- Investigated and identified radon daughters as a source of noble gas monitor alarms following specific processes conducted at a PWR.
- Long-term participant in voluntary meetings among radiological environmental monitoring programs along the Savannah River. Meetings provide a forum for maintaining contacts and exchanging information regarding measurements and site activities.
- Evaluated basis for batch release calculations of tritium concentrations and presented results to natural resource agencies and downstream water users. Successfully communicated how facility operations were conducted and demonstrated that batch release calculations were reliable estimates of downstream concentrations.

Corporate radiation safety

Managed six specific licenses including license requirements, license amendments, training, emergency response. Licenses include sealed sources for density gauges, radioactive materials

for instrument calibrations and in effluent samples from nuclear facilities, industrial radiography with Ir-192 and Se-75, sealed sources in gas chromatographs, and a Cs-137 beam irradiator.

- Developed a corporate guideline for use of radioactive materials available through the corporate intranet. The guideline includes license requirements, license amendment procedures, emergency response information, and addresses common questions regarding exempt and generally licensed radioactive materials.
- Developed and implemented increased controls for radioactive materials in quantities of concern. Coordinated security evaluation with corporate security, developed security plans, arranged installation of increased controls, contacted law enforcement agencies, and reviewed implementation. Increased controls implemented as scheduled and no issues were found during regulatory inspections.

<u>Experience with resolving environmental issues with federal and state agencies</u>

Hydroelectric licensing to meet NEPA requirements under 18 CFR Part 5.

Participated as a management team member on the Integrated Licensing Process for renewal of a FERC License to operate Morgan Falls Hydroelectric Project (FERC Project 2237). This relicensing process implements NEPA requirements under 18 CFR Part 5 " Integrated License Application Process ". Morgan Falls is a 16.8 MW project located on the Chattahoochee River in Atlanta, Georgia, and impounds 230-acre Bull Sluice Lake.

- Participated in biweekly Reservoir Project Team meetings with hydro operations, engineering, consultants, legal counsel, and licensing representatives.
- Managed environmental studies implemented by my staff, coordinated activities with other departments and consultants, participated in development and review of study plans, evaluated and developed responses to study requests, and implemented study plans. Areas of supervisory responsibility included: water temperature and water quality monitoring; fish and aquatic resources; wildlife and botanical resources; wetlands, riparian, and littoral habitat; and rare, threatened, and endangered species.
- Participated in public scoping meetings, presentation of study results, formal dispute resolution, and in negotiation of study plans and results.
- Significant contributions include:
  - management of a continuous water temperature monitoring study designed to determine the affect of project operations on increases in water temperature;
  - resolution of a study request for an additional Instream Flow Incremental Methodology (IFIM) study that went through formal dispute resolution; and
  - Resolution of study results from an independent sediment contaminant study implemented by an NGO.

316(b) studies required under the Clean Water Act

Participated on an interdisciplinary team evaluating EPA proposed and final rules for implementing section 316(b) of the Clean Water Act for existing facilities (67 Fed. Reg. 17, 122-225 (April 9, 2002)). Team members included representatives from engineering, licensing, power generation, and legal counsel.

- Reviewed EPA's proposed rule for impingement and entrainment at existing facilities with once through cooling, evaluated the basis for the rules, and submitted written comments and questions to US EPA.

- Assembled and reviewed existing impingement data and the case studies forming the bases for the proposed performance criteria.
- Evaluated operating characteristics of existing facilities and developed strategies for complying with the proposed rule for impingement and entrainment.
- Supervised the start-up of impingement sampling for a large fossil plant, including initial contact with plant operations and safety, development of sampling equipment, sampling strategy, procedures, and record keeping.
- Completed the first comprehensive impingement demonstration study within our company under the revised 316(b) rule.
- Initiated meetings with the state natural resource agency to discuss the 316(b) requirements and our implementation of the study plan. Presented the monitoring results and addressed questions from the natural resource agency.

License Renewal of Nuclear Plants

Participated in license renewal for Edwin I. Hatch nuclear plant (HNP), evaluating, conducting research, synthesizing results regarding potential environmental impacts as required for NUREG 1437 "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," to meet requirements of 10 CFR Part 54 and 10 CFR Part 51.

- Initially reviewed license renewal regulatory guidance, coordinated an evaluation of environmental issues, identified supporting expertise, and assembled a project team within Environmental Affairs.
- Contacted state and federal natural resource agencies regarding the license renewal process.
- Arranged a survey of native mussels in the vicinity of the facility, documenting the presence and number of native mussels upstream and downstream of the facility in response to interest from the USFWS.
- Evaluated historic data including five years of impingement collections, three years of entrainment measurements, and thermal plume measurements and model results.
- Assembled and evaluated research reports on the status of short nose sturgeon in the Altamaha River. Compared impingement rates and status of populations with studies from the Hudson River, New York. Written results and presentations were provided to US National Marine Fisheries Service, US Fish and Wildlife Service, and the US Nuclear Regulatory Commission resulting in the conclusion the continued operations were not likely to affect short nose sturgeon in the Altamaha River.

Cooperative conservation effort under the Federal Power Act and the Endangered Species Act

Developed the Conservation Strategy for robust redhorse (*Moxostoma robustum*) and Conservation Agreement with Assurances for the Ocmulgee River. Participants include U. S. Fish and Wildlife Service, Georgia, South Carolina, and North Carolina natural resource agencies, university researchers, and investor owned utilities.

- Negotiated and wrote the conservation strategy describing status and goals for enhancing the survival of robust redhorse within its historic range.
- Influenced long-term cooperative conservation effort through participation in annual and executive committee meetings.
- Cooperative efforts identified two additional native populations and reintroduced the species in five river systems within the historic range.
- Evaluated and prioritized research proposals. Managed $2.4 million in research funding, reviewed progress reports, and facilitated publication of research reports.

- Negotiated the first Candidate Conservation Agreement with Assurances (CCAA) between U.S. Fish and Wildlife Service and a non-governmental organization (Candidate Conservation Agreement with Assurances for the Ocmulgee River).
- Successful development of the CCAA was recognized through participation in USFWS Conservation Agreement workshop and Georgia DNR Conservation Agreement/Habitat Conservation Plan workshop (see www.robustredhorse.com).
- Attended Senate staff briefing regarding the role of Candidate Conservation Agreements in conservation of rare species in the context of the Endangered Species Act.
-

Information management and evaluation

Managed four analytical laboratory sections providing Radiochemistry, Dosimetry, Fuel, and Chemistry analytical services supporting nuclear, fossil, and hydro generation as well as transmission, distribution, and corporate organizations.

- Supported three nuclear power plant sites with effluent and environmental measurements (approximately 5,000 analyses per year), and personnel dosimetry (approximately 20,000 measurements per year).
- Provided governing coal quality measurements for 14 fossil generation facilities (13,240 samples per year) with fuel costs exceeding $1 billion annually.
- Provided analytical chemistry services for fossil and hydro generation (2900 analyses per year), nuclear plant process chemistry (1900 analyses per year), and corporate support including remediation (2750 analyses per year).
- Supervised development of the specifications for the current laboratory information management system used to track samples from receipt, automate transfer of measurements, provide electronic reporting of results, and track quality control data. Supervised the installation, configuration, and subsequent upgrades to this system.
    - Provides electronic transmittal of analytical results.
    - Improves coordination across analytical areas through use of a common system.
    - Implements full audit tracking and documentation.
- Implemented uniform quality assurance program under ISO 17025 covering all analytical sections.
    - Conduct a routine review of performance testing results, internal quality control measurements, and workload that is uniform across all sections.
    - Schedule, implement and review internal audits of procedures, documentation, and results.
    - Established common administrative procedures for support activities including procurement, quality assurance, information technology, training, safety, and record archiving.
- Provide statistical consultation. I completed a minor in mathematical statistics at the Georgia Institute of Technology December, 1993, consisting of 19 quarter hours of training in applied and mathematical statistics. Representative projects include:
    - Designing a statistical approach to sampling substations by region for use of a potential contaminant.
    - Developing the sampling strategy for PCBs in substation based on EPA grid methodology and estimating the probability of not detecting spills.
    - Evaluating concentrations of trace elements in groundwater from pre-operational sampling to establish control limits for groundwater monitoring.
    - Research regarding background concentrations of trace elements and regulatory programs used by state and federal regulatory programs.

- Managed complex analytical programs required for assessment of Municipal Gas Plant (MGP) investigations under the Georgia Hazardous Site Response Act. Reviewed study plans, analytical methods, and coordinated with site personnel regarding sample documentation, delivery, and analytical requirements. Projects include:

Americus MGP Project
Management of analytical services for the assessment. Evaluated, selected, and coordinated contract laboratory services for leachability study. Analyzed samples for metals, PAHs, volatile organics, TPH, cyanide, sulfide, hazardous waste characteristics, and various physical parameters. Total of 625 samples

Athens MGP Project
Completed third party validation of project data. Provided customized data summary packages to project management. This project was complicated by the presence of lead contamination from an adjacent incinerator site.
Total of 450 samples

Brunswick LCP Project
Monitored on-site analytical program for metals, volatile, and semivolatile organic compounds, including site reviews. Investigated analytical issues related to the on-site analyses of groundwater for lead and found the equipment inappropriate for the detection limits required. Developed specifications and requirements for on-site analytical support, participated in contractor selection, and reviewed required performance data. Conducted on-site evaluation of analytical capabilities.

Network Underground MGP Project
Management of analytical services for the project. Analyzed samples for metals, PAHs, volatile organics, TPH, cyanide, sulfide, hazardous waste characteristics, and various physical parameters. Managed contract laboratory workload, reviewed analytical results.

McManus HSRA Project
Managed analytical portion of the assessment, including analyses of soil and water for metals, PCBs, and hazardous waste characteristics. Total of 261 samples

Moultrie HSRA Project
Managed analytical portion of the assessment and remediation. Performed analyses of soil and water samples for PCB and hazardous waste characteristics. Total of 700 samples

Selected Presentations and Papers

Status – Georgia Power Mercury and Chlorine measurements. M. Nichols, T. Cornett, and L. Biddy. Presented to Southern Company Mercury Emissions Information Collection Task Force, April 26, 1999.

Biological Information Update for NMFS, Edwin I Hatch Nuclear Plant, License Renewal, J. T. Davis, Southern Nuclear, M. C. Nichols, Georgia Power, A. S. Hendricks, Georgia Power, January 24, 2000

Statistics for Environmental Measurements, presented November 9, 2000 for the Central Savannah River Radiological Environmental Monitoring Programs meeting, Amicola Lodge, Georgia.

Savannah River tritium concentrations - 1999, presented June 7-8, 2000 for the Central Savannah River Radiological Environmental Monitoring Programs meeting, Jekyll Island, Georgia.

Conservation Agreement Case Studies - Robust Redhorse. State Conservation Agreement Workshop, USFWS National Conservation Training Center, Shepardstown, W. Va. Nov 1-2, 2000.

Candidate Conservation Agreement with Assurances - Ocmulgee River. Agreement Number 1448-40181-01-K-005. Federal Register: October 30, 2001 (Volume 66, Number 210)]

Biological Information Update for USNRC, Edwin I. Hatch Nuclear Plant License Renewal. J. T. Davis, Southern Nuclear, M. C. Nichols, Georgia Power, A. S. Hendricks, Georgia Power
T. C. Moorer, Southern Nuclear, March 31, 2001

Robust Redhorse Conservation Strategy, February 25, 2003. Presented to and adopted by the Robust Redhorse Conservation Committee.
http://www.robustredhorse.com/f/ConservStrategyMay62003.pdf

Affidavit of Michael C. Nichols, Georgia Power's Responses to Filings on the Final Study Report and the Study Results Meetings (for the Morgan Falls Project). FERC Docket P-2237-013, Accession number 20060627-0034. Results of assessment from reviewing analytical results and laboratory processes related to a sediment contaminant study conducted by the Upper Chattahoochee Riverkeeper and the USFWS.

Vogtle Electric Generating Plant Tritium Releases, presented 09/26/06 for the Central Savannah River Radiological Environmental Monitoring Programs meeting, Georgia Tech Research Institute, Atlanta, Georgia. Discusses batch release calculations, procedures, and compares calculated results with continuous sample results collected 30 miles downstream.

Total Uncertainty Estimates using GUMCalc, presented to the Atlanta Chapter of the Health Physics Society, April, 2007.

Comparison of Measured Counting Efficiencies for C-14, Sr-89, Sr-90, and Y-90 with estimates from a Monte Carlo Model. M. C. Nichols and B. Kahn, Health Physics Society Annual meeting, July 9-12, 2007, Portland, Oregon.

Addressing uncertainty in radiochemistry measurements. 19th Annual RETS-REMP meeting, South Bend Indiana, June 21-24, 2009

Education

Georgia Institute of Technology, Atlanta, Georgia US Master's Degree - 5/1985
80 Quarter Hours
Major: Health Physics
Minor: Mathematical Statistics
GPA: 3.8 out of 4.0

Relevant Coursework, Licensures and Certifications:

Calculus I-V and Differential Equations
Radiation Detection I
Advance Radiation Detection
Health Physics Practice
Environmental Surveillance and Waste Disposal
Industrial Health Protection
Biological Effects of Radiation
Intro Nuclear Materials
Radiation Dosimetry
Fundamentals Nuclear Engineering
Small Computer Interface
Additional Graduate Courses (minor mathematical statistics)
Mathematical Statistics
Design of Experiments
Experimental Statistics
Applied Regression Analysis I

University of Georgia, Athens, Georgia US, Master's Degree - 5/1978

65 Semester Hours
Major: Zoology
GPA: 3.53 out of 4

Relevant Coursework:

Advanced Biochemistry I and II
Limnology and Oceanography
Invertebrate Zoology I and II
Problems in Zoology I and II
Freshwater Biology
Ichthyology
Statistical Methods I and II
Multivariate Methods

University of Michigan-Flint, Flint, Michigan US,
Graduate A.B. Biology, with High Distinction - 5/1978
120 Semester Hours
Major: Biology

Professional affiliations

Reviewer – Standard Methods for Analysis of Water and Wastewater

- Reviewed and commented on method 1090C Laboratory Hazards, aligning radiation safety guidance with actual laboratory uses of radioactive materials.
- Reviewed and commented on section 7000 methods for radioactivity, particularly 7010G - statistics, 7110 - Gross Alpha and Gross Beta Radioactivity, 7500-I Radioactive Iodine, and 7500 - H Tritium.

Health Physics Society

- Presentations (oral and poster sessions)
- ABHP passing point evaluation
- Represent local chapter at chapter council meetings

Atlanta Chapter, Health Physics Society

President, 1993, 2007.

- Successfully revived local chapter activities in 1993. The chapter subsequently sponsored a regional workshop on electronic dosimetry, hosted a national meeting, and implemented science teacher workshops.
- Served as president of the local chapter, providing monthly meetings addressing the diverse interests of the professional health physicists in Atlanta.
- Currently chairing the local chapter Science Education Committee, developed an educational program supporting high school science teachers interested in radioactivity and radiation based on USNRC lesson plans. Implemented a science teacher workshop at the 2009 Georgia Science Teachers Association meeting.